

Progress Report

June 24, 2015

Steam Enhanced Extraction at the Former Williams AFB,
ST012 Site

Mesa, AZ



1. Summary

This report covers the period of operations from Tuesday, June 16, 2015 through Monday, June 22, 2015. The following table provides a summary of the project operational status.

Table 1. Project Summary

	Value	Unit
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)
Area	199,000	square feet (ft ²)
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)
Lower Depth of Treatment	245	ft bgs
Vapor Liquid Treatment Started	09/29/14	
Thermal Operations Started	09/29/14	
Last Process Data Update	06/22/15	
Last Temperature Data Update	06/22/15	
Estimated Total Days of Operation	422	days
Days of Operation	266	days
Days of Operation vs. Estimate	63	percent (%)
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)
Total Energy Used	2,413,253	kWh
Used Electrical Energy vs. Estimate	21	%
Total Steam Injected	158.8	million pounds (lbs)
Projected Total Steam Injection	320	million lbs
Steam Injected Vs Projected	50	%
Total Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	497,956	lbs
Total Mass Removed as NAPL	827,738	lbs
Average Daily NAPL Mass Removal Last Week	9,950	lbs/day
Total Vapor and Liquid Mass Removal (based on PID readings)	1,325,694	lbs
Average Power Usage Rate Last Week	476	kilowatts (kW)
Average Wellfield Vapor Extraction Rate Last Week	888	standard cubic feet per minute (scfm)
Average Condensate Production Rate Last Week	3.2	gallons per minute (gpm)
Average Water Extraction Rate Last Week	127	gpm
Total Water Extracted	40,799,672	gallons
Total Recovered Light Non-Aqueous Phase Liquid	125,796	gallons
Average Water Discharge Rate Last Week	187	gpm
Total Treated Water Discharge	53,059,000	gallons

Operational highlights from the past week include:

- Repairs at TMPs 01, 04 and 05 were completed on June 19 and June 20, 2015. Data from these TMPs have not been included in this week's temperature average.
- Troubleshooting efforts at TMP 07 have shown that the newly installed array is not functional and will not be able to be placed back online.
- A partial depressurization of the central part of the LSZ was initiated on Tuesday June 16, 2015. Wells SIW LSZ 03, 07, 19, 24 and 41 were all dialed back to low injection

rates. The partial depressurization was initiated to repair a wellhead fitting on MPE LSZ 05.

- On Monday June 22, 2015 the UWBZ steam injection wells previously included in the UWBZ depressurization cycle were turned back on except UWBZ SIWs 03 and 07 (pilot wells – turned up later in the operational week).
- At the same time all remaining LSZ wells were dialed back to be included in a full LSZ depressurization round.
- Extraction wells LSZ05, LSZ37 and UWBZ05 have produced a significant amount of steam in the vapor phase over the past week.
- The average steam injection rate in the LSZ was 17,400 lbs/hr (or 34.3 gpm).
- The average steam injection rate in the UWBZ was 3,300 lbs/hr (or 6.6 gpm).
- All six eductor skids were operated continuously. The average liquid extraction rate from the formation was approximately 127 gpm.
- The average steam injection rate last week was 40.9 gpm. The net extraction from the formation was 210% (more than 3 times the water volume injected as steam was extracted as water).
- Collected process, wellfield and laboratory data per the sampling schedule.
- Conducted regular maintenance on the treatment system.
- The following MPE wells still require maintenance (please note that the cobble zone wells were identified week ending June 15, 2015 during testing efforts of the cobble zone MPE wells prior to initiating steam injection in the cobble zone – the cobble zone wells were not a part of the original eductor well pump pulling and replacement):
 - LSZ-05* (previously identified as requiring maintenance)
 - LSZ-06* (previously identified as requiring maintenance)
 - LSZ-15
 - LSZ-37*
 - UWBZ-05* (previously identified as requiring maintenance)
 - UWBZ-27
 - CZ-15
 - CZ-17
 - CZ-18
 - CZ-08

*MPE wells at steam temperatures – maintenance cannot be performed presently due to health and safety concerns

The following MPE wells were pulled and repaired during this operational period:

- LSZ-30
- CZ-09
- CZ-13

Please note that CZ-09 will be brought back online once a Y-strainer has been installed at that location. LSZ-30 and CZ-09 are functional.

2. Vapor Extraction

Figure 1 below shows the vapor extraction rate from the site. Note that the estimated steam extraction rate is a calculated value based on the water generated at the moisture separators after cooling the vapors from the wellfield. Based on energy balance analysis, additional steam is likely being pulled into and condensing in the liquid extraction system. This steam extraction is not measureable and not accounted for in Figure 1. Additionally the wellfield flow is calculated as the difference between the air stripper flows and thermal accelerator influent, and is therefore only an estimate.

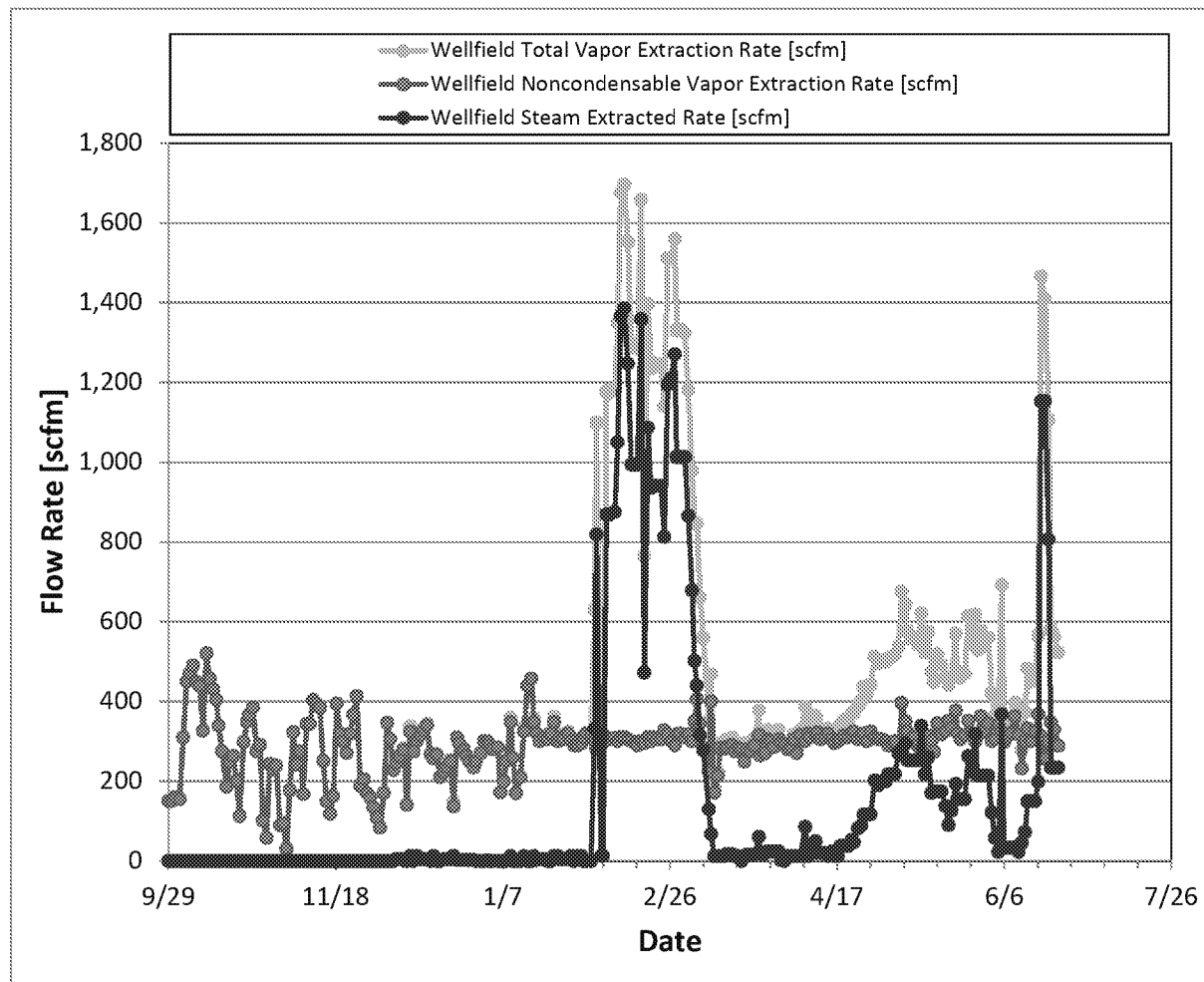


Figure 1. Vapor Extraction Rate

Note: Well SVE01M was tied into the SEE extraction system on June 5, 2015.

3. PID Measurements

The following figure depicts the PID concentrations from the wellfield effluent to the effluent of the thermal accelerators collected since the start of operations. Note that PID readings of 0.0 parts per million by volume (ppmV) are shown in the figures as 0.01 ppmV due to the logarithmic scale that does not allow display of 0-values. Accelerator influent readings are interpolated for days where no data is collected, since the value is used in the mass removal calculation.

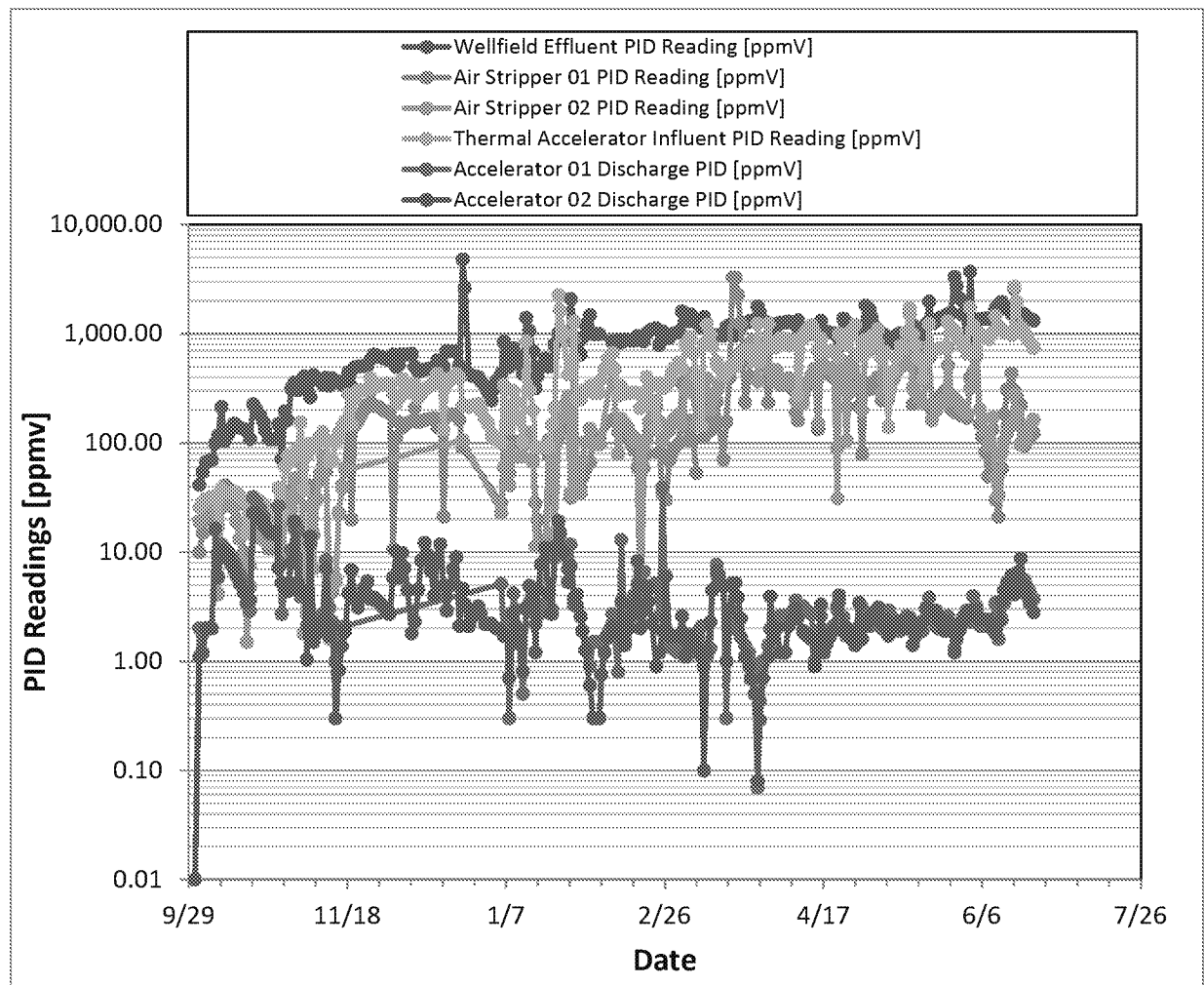


Figure 2. PID Readings

4. Mass Removal

The mass removal is calculated based on the PID and laboratory data collected at the thermal accelerator influent and the LNAPL recovered. The figure also depicts the mass removed based on PID and laboratory data.

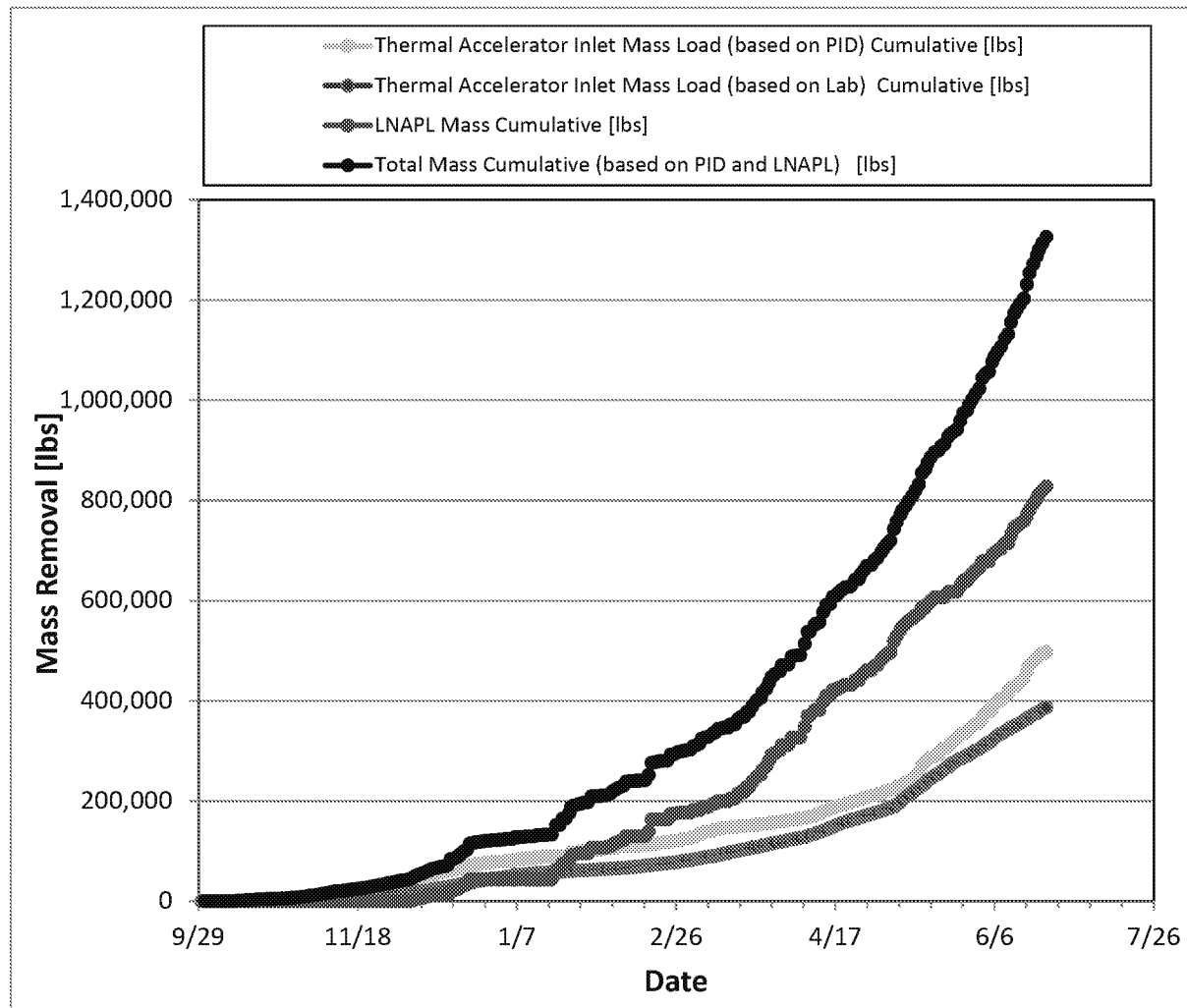


Figure 3. Mass Removal

Note: A NAPL density of 6.58 lbs/gallons was used to convert the NAPL volume to pounds.

5. Daily Mass Removed

Figure 4 outlines the daily mass removed as vapor and LNAPL. The total daily mass removed is the combination of vapor and LNAPL. The liquid mass removal is captured in the vapor phase due to the volatilization of liquid contaminants in the air strippers.

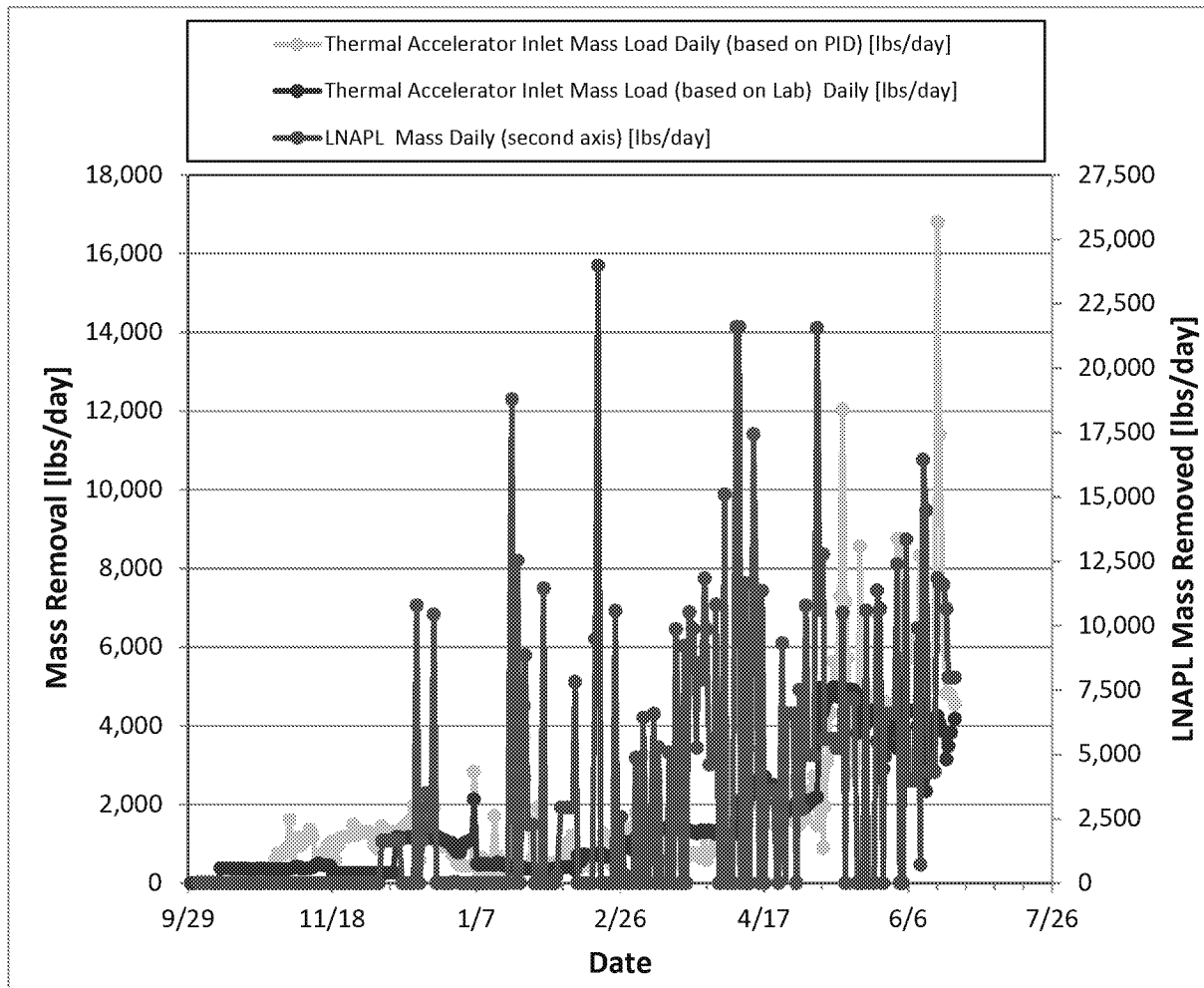


Figure 4. Daily Mass Removed

Note: Laboratory data are not collected daily. The “Thermal Accelerator Inlet Mass Load (based on lab)” is an average daily rate of actual lab data collected. Note that accumulated LNAPL is pumped through the NAPL conditioning system in a batch style process.

6. Power Usage

The cumulative power usage is shown below. All electricity used at the site is utilized to run the process system and steam generators.

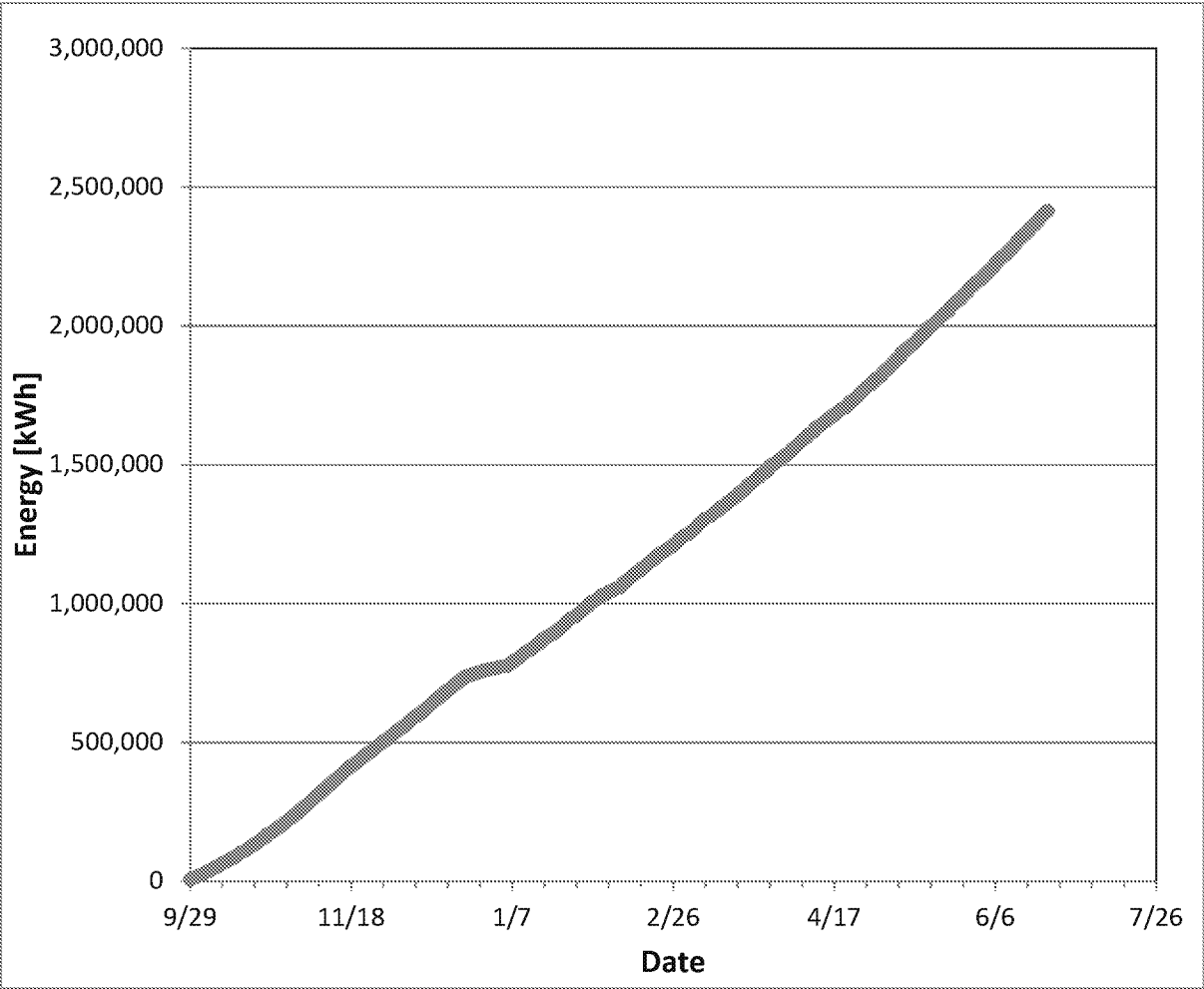


Figure 5. Cumulative Power Usage

7. Average Temperature

The average soil temperatures as degrees Celsius ($^{\circ}\text{C}$) and degrees Fahrenheit ($^{\circ}\text{F}$) are shown in the figure below by treatment zone (i.e., LSZ, UWBZ and Cobble Zone [CZ]). Please note that six temperature monitoring arrays (TMPs 01, 04, 05, 06, 07, and 09) were offline during this operational period, and therefore the temperatures from these wells have been excluded in the average temperature calculations.

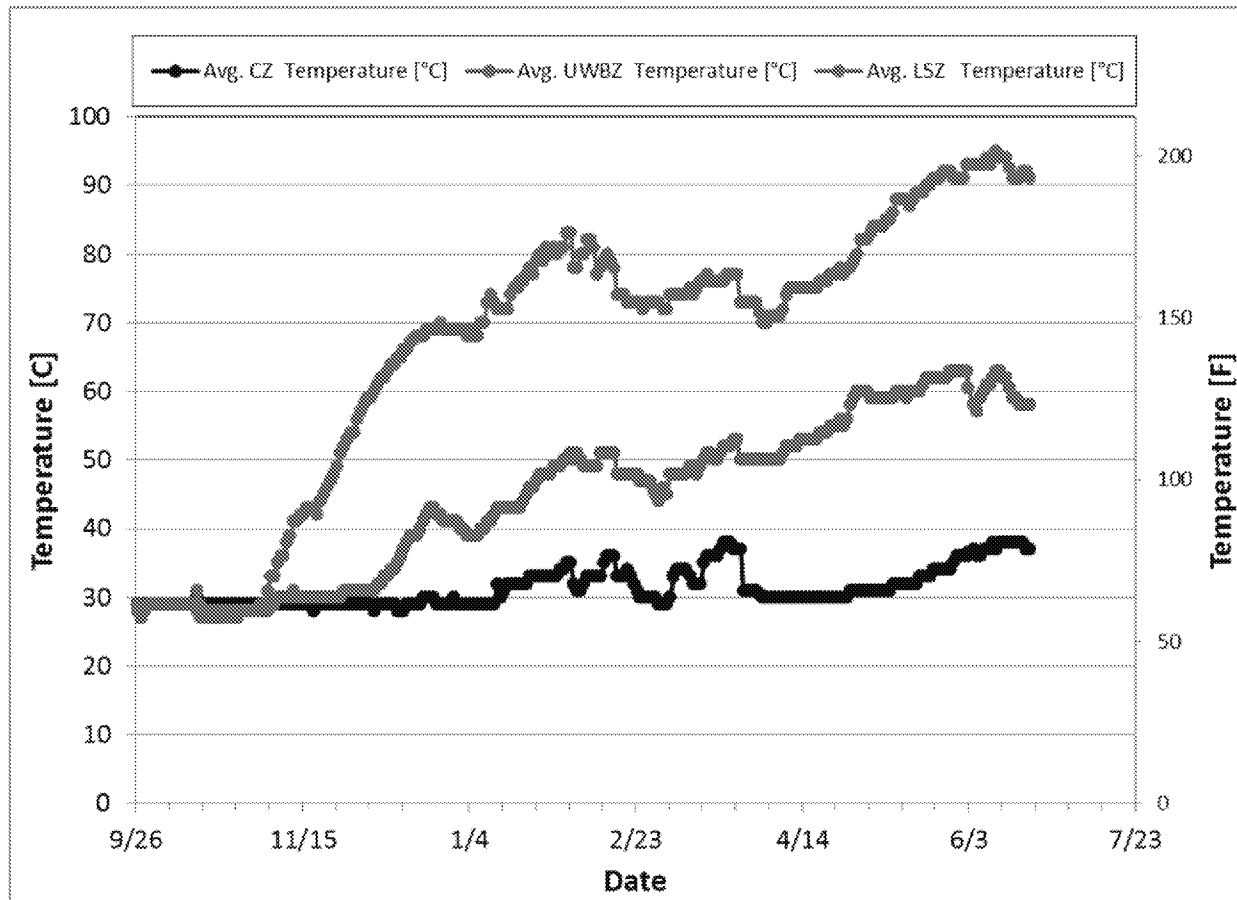


Figure 6. Average Soil Temperatures

Note: The replacement sensors installed in TMPs 06, 07, and 09 are not reading correctly and require additional troubleshooting; therefore, the temperatures have not been included on this figure. Repairs to TMPs 01, 04 and 05 were replaced during this operational period and the sensor hookup is in progress.

8. Vertical and Horizontal Temperature Profiles

The following Figures 7 and 8 show the temperature in °C versus depth profiles for each of the 17 individual temperature monitoring points (as stated above, TMPs 01, 04, 05, 06, 07, and 09 were offline during this operational period). Figures 9-12 show the horizontal temperature distribution across the site in four depth intervals.

Temperature highlights for the past week include:

- The heat up rate at perimeter well TMP 2 at 215 ft bgs has decreased by 2°C the past week and is now at 58°C.
- TMP 10 shows steam temperatures in the 205 to 230 ft bgs interval.
- TMP 11 has cooled down in the 170-180 ft bgs interval from steam temperatures (110 °C) to approximately 73°C.
- TMP 13 has seen an approximate 5°C decrease in the 195-235 ft bgs depth.
- TMP 16 has shown slight decreases over the last week in the 175-185 and 200-235 ft bgs depths.

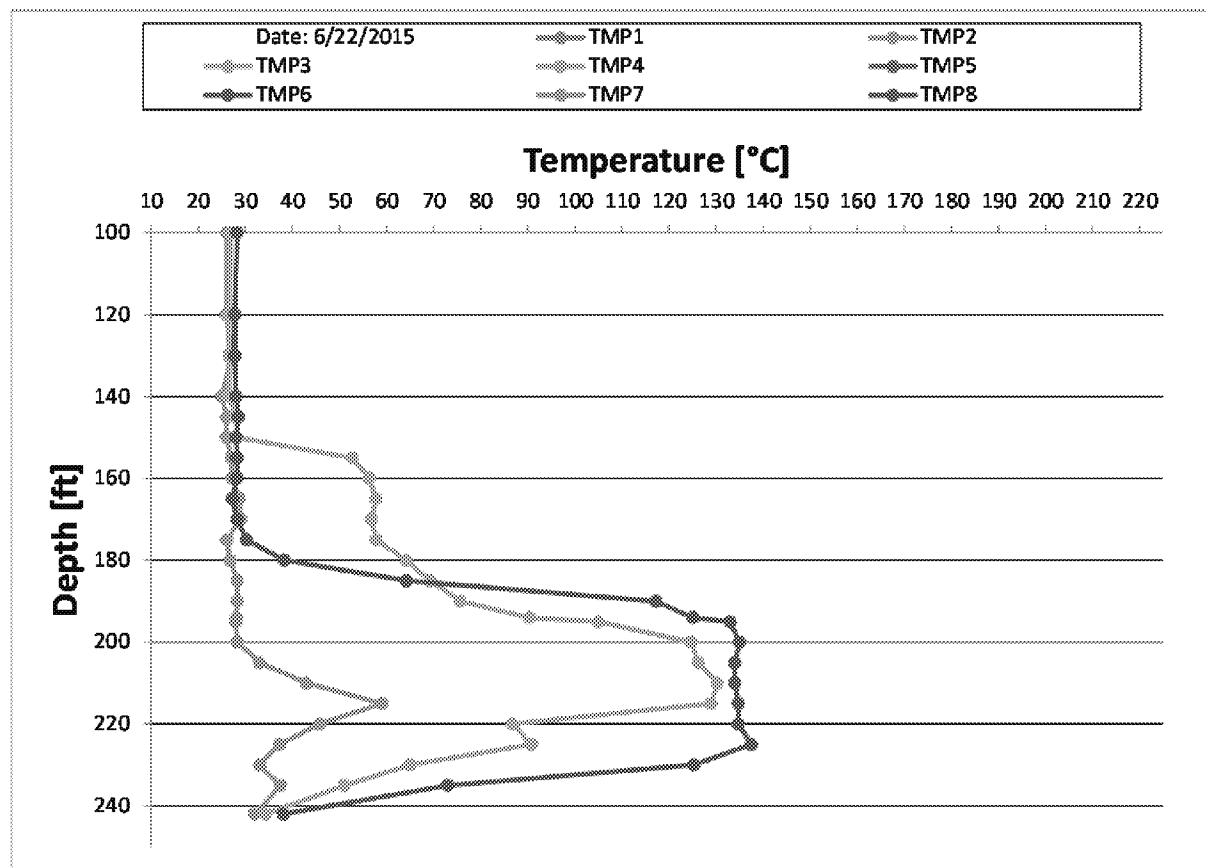


Figure 7. Vertical Temperature Profiles (TMP1 through TMP8)

Note: TMPs 01, 04, 05, 06, 07, and 09 were offline during this operational period.

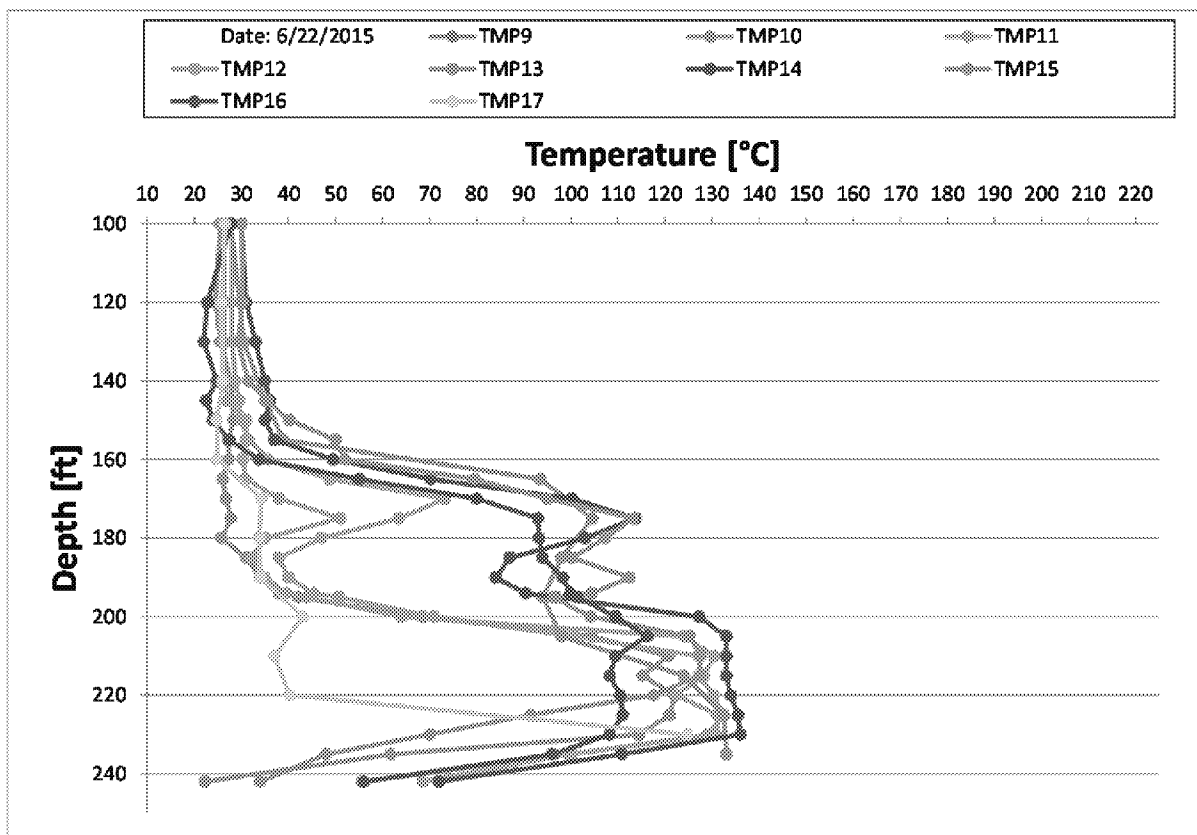


Figure 8. Vertical Temperature Profiles (TMP9 through TMP17)

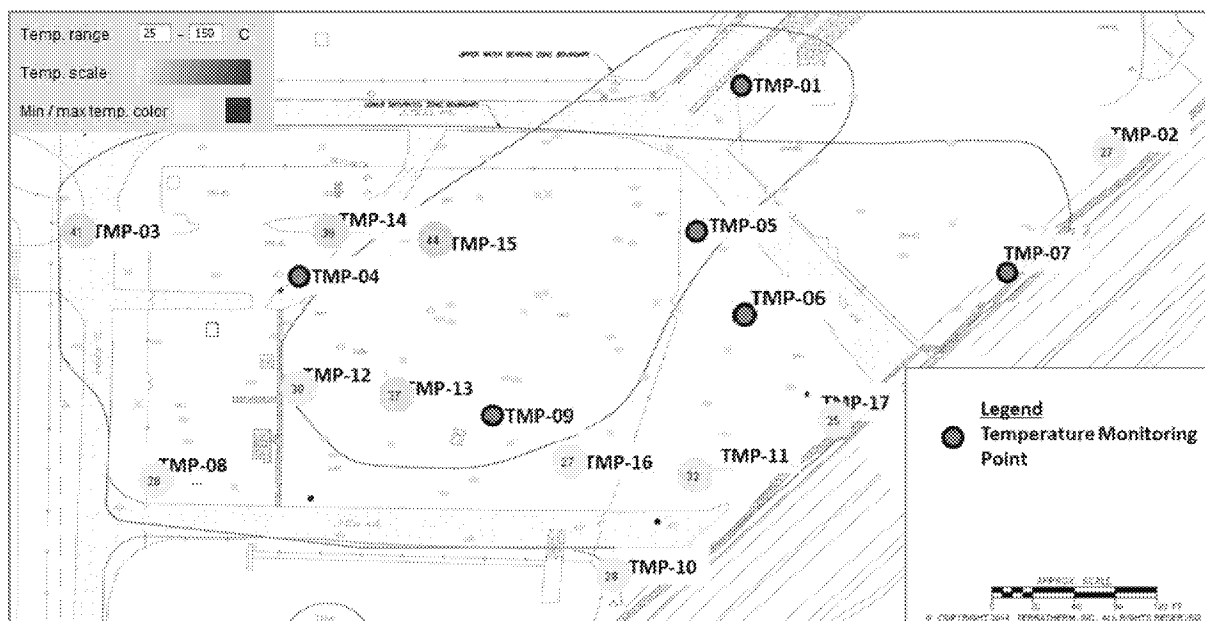


Figure 9. Horizontal Temperature Distribution across the CZ (145-160 ft bgs) (temperatures shown in °C)

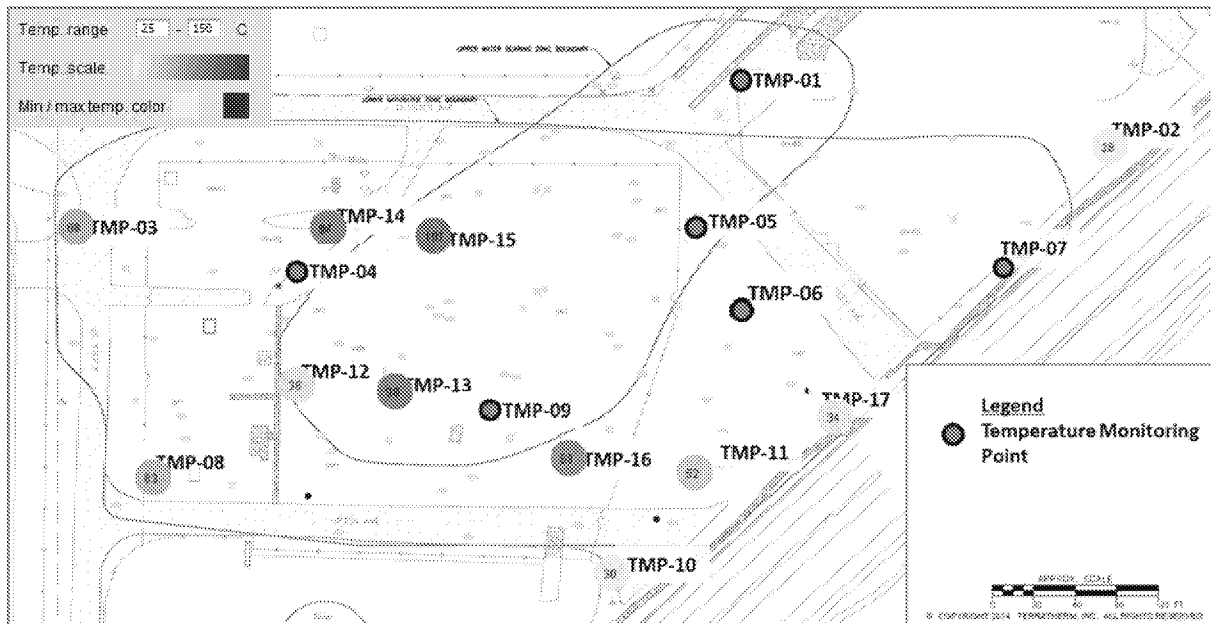


Figure 10. Horizontal Temperature Distribution across the UWBZ (161-195 ft bgs) (temperatures shown in °C)

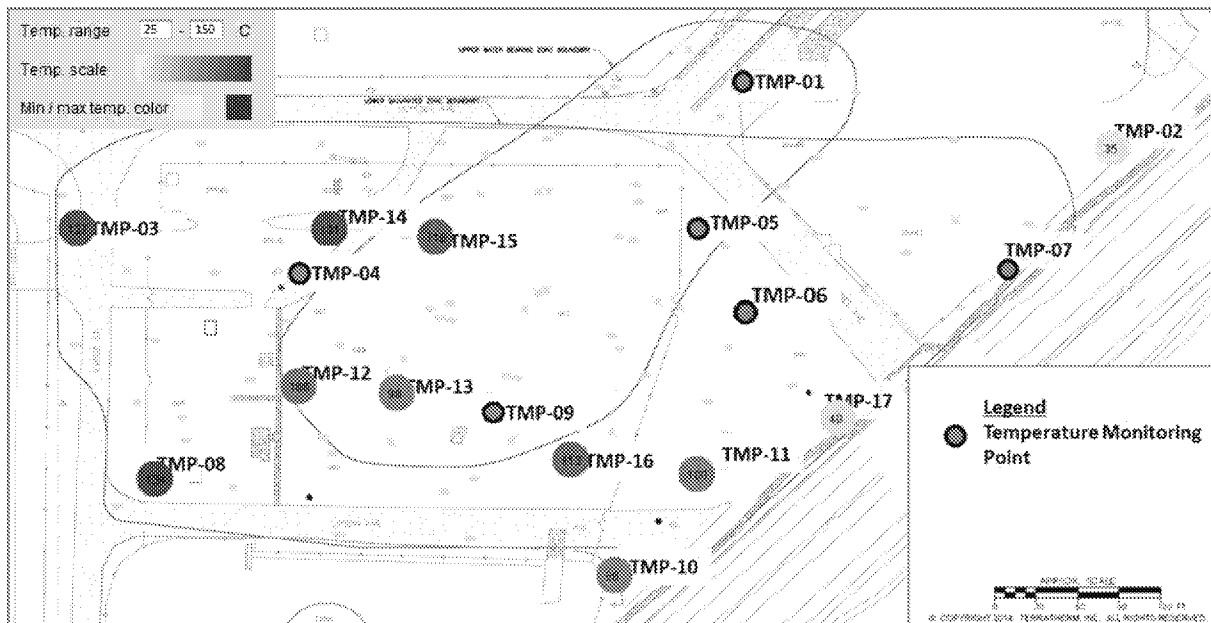


Figure 11. Horizontal Temperature Distribution across the Lower Permeable Zone (196-210 ft bgs) (temperatures shown in °C)

Note: The replacement sensor installed in TMP-13 within the LPZ zone is not reading correctly and therefore the temperature has not been included on this figure.

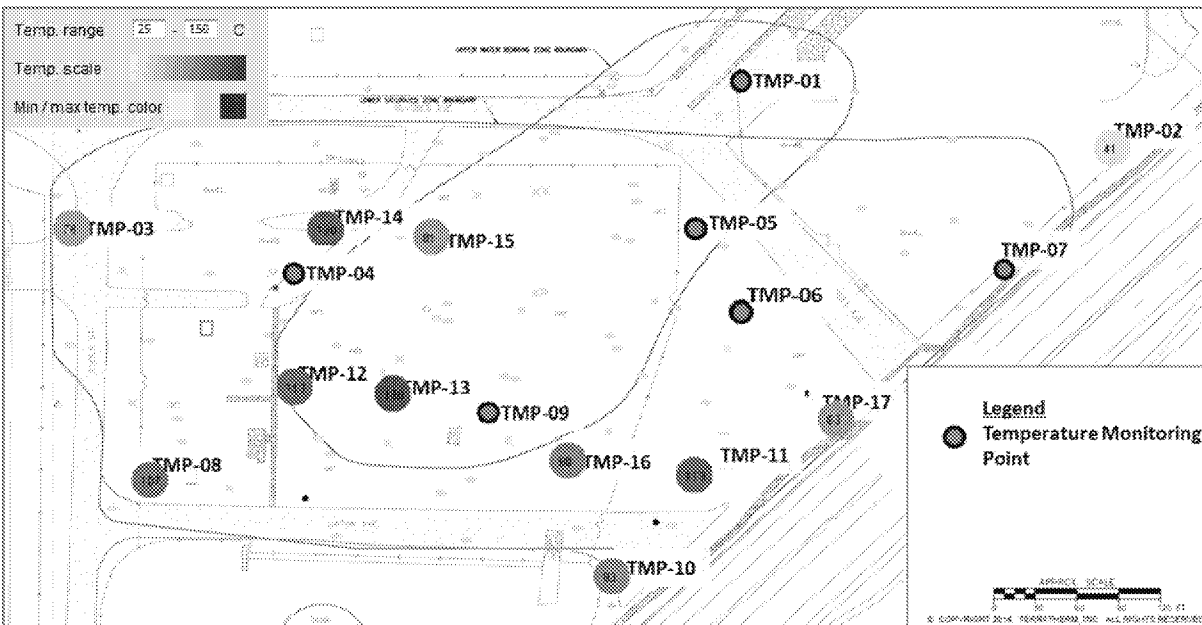


Figure 12. Horizontal Temperature Distribution across the LSZ (211-245 ft bgs) (temperatures shown in °C)

Figure 13 below shows the observed temperatures by depth at selected LSZ extraction wells.

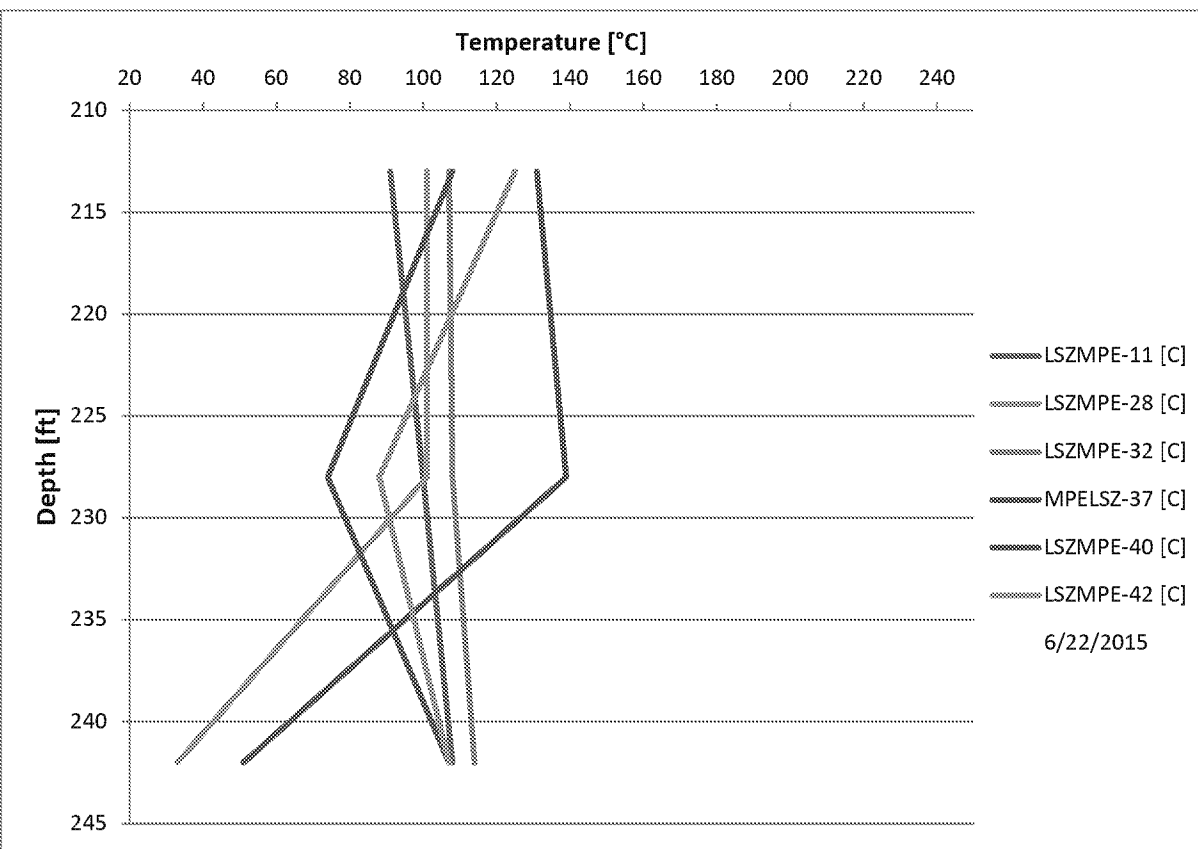


Figure 13. Temperatures by Depth at Selected LSZ Extraction Wells (211-245 ft bgs) (temperatures shown in °C)

9. Cumulative Steam Injection

Steam injection was initiated Thursday, October 16, 2014. Figure 14 below shows the cumulative steam injection for each of the three injection zones.

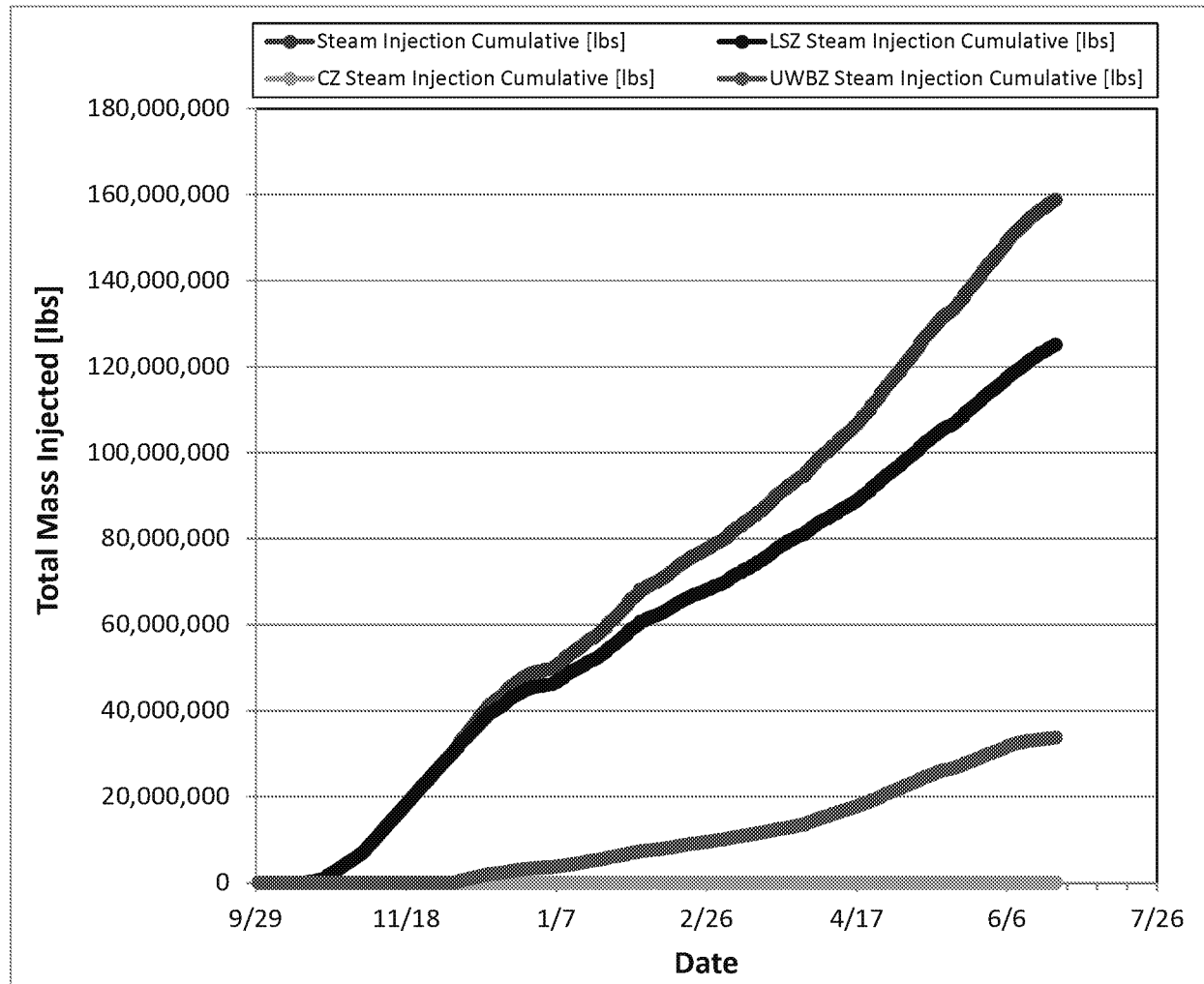


Figure 14. Cumulative Steam Injection for Each of the Three Injection Zones

Note: The steam injection has not yet been initiated in the CZ.

10. Steam Injection Rates

The figure below shows the steam injection rates for each of the three injection zones.

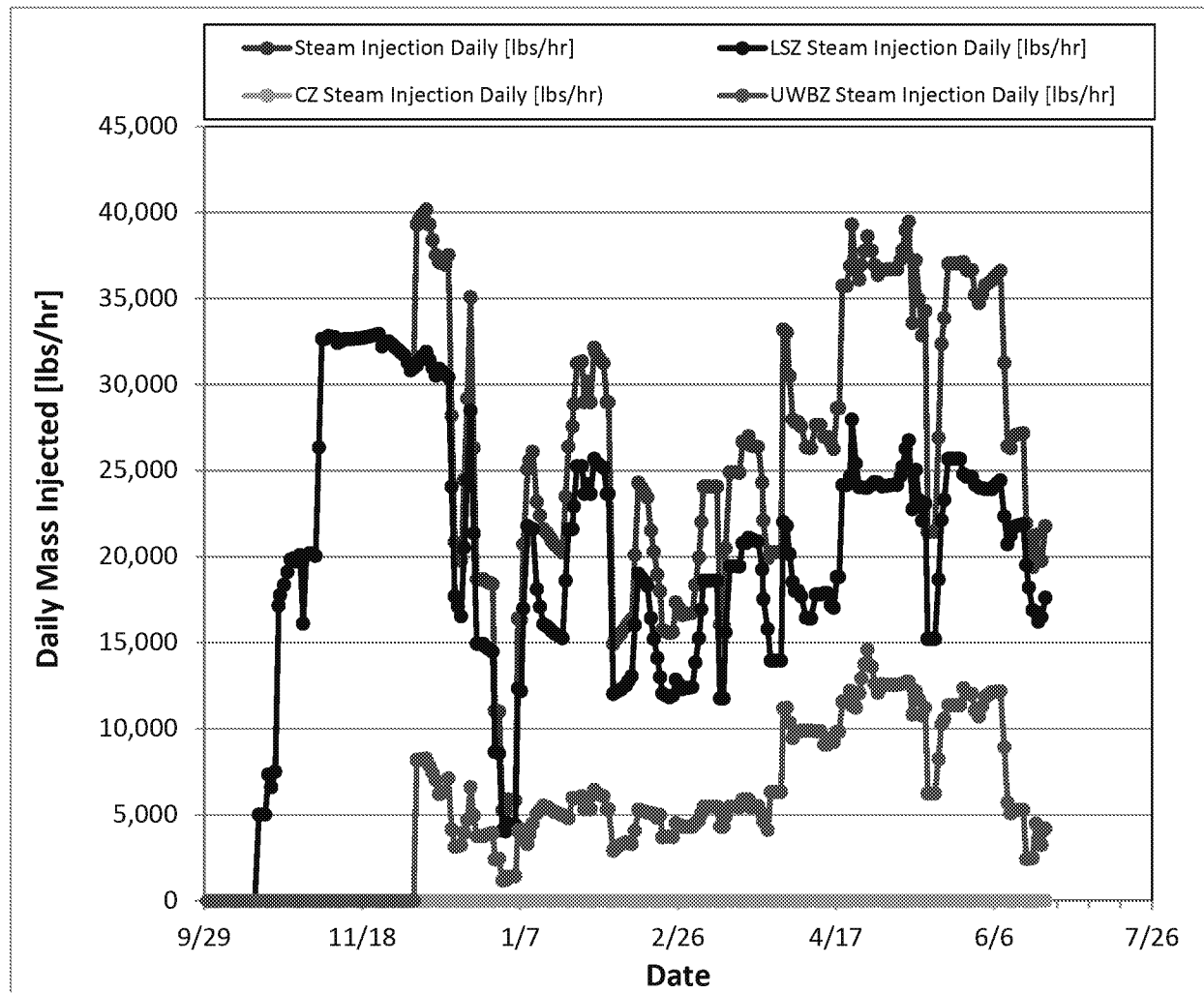


Figure 15. Steam Injection Rate for Each of the Three Injection Zones

Note: The steam injection has not yet been initiated in the CZ.

11. Cumulative Water Extraction by Zone

The cumulative water extraction for each of the three treatment zones is shown below. The cumulative water extraction is calculated based on flow meters installed at each of the 57 extraction wells (accuracy should be considered +/- 20%). The figure below shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

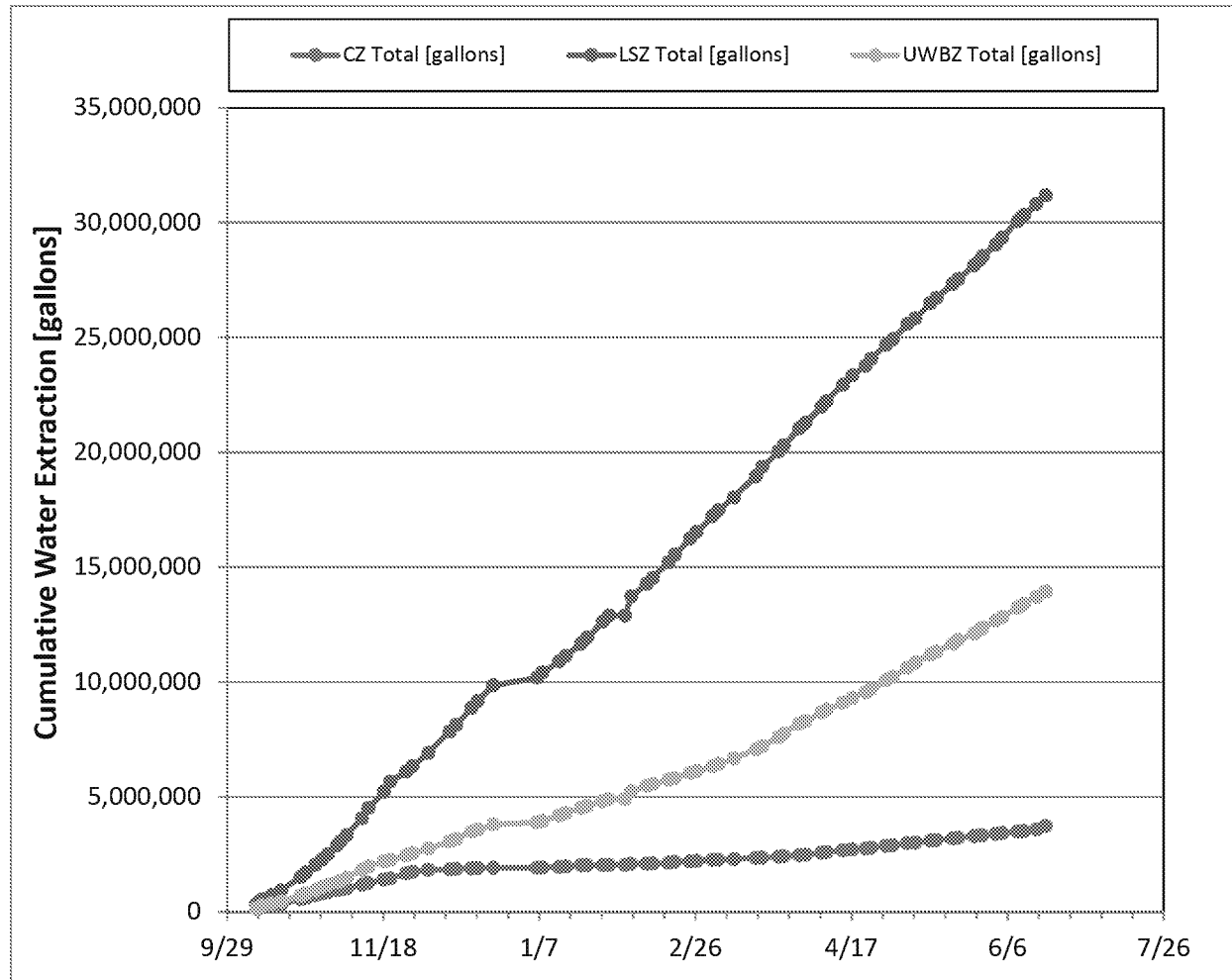


Figure 16. Cumulative Water Extraction for Each of the Three Treatment Zones

12. Water Extraction Rates by Zone

The figure below shows the water extraction rates for each of the three treatment zones.

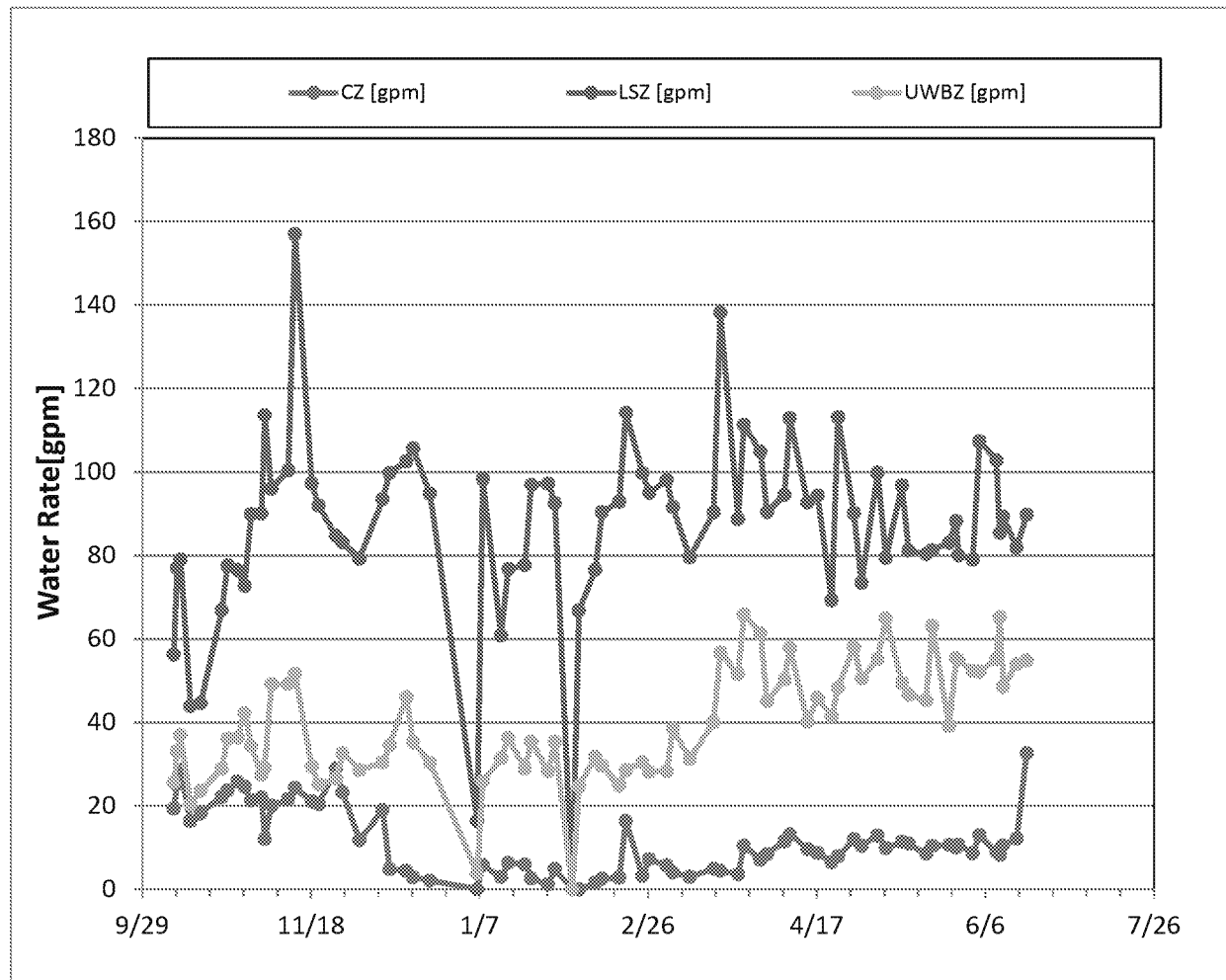


Figure 17. Water Extraction Rates for Each of the Three Treatment Zones

13. Cumulative Water Balance

The cumulative water balance for the site is shown below. The chart shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

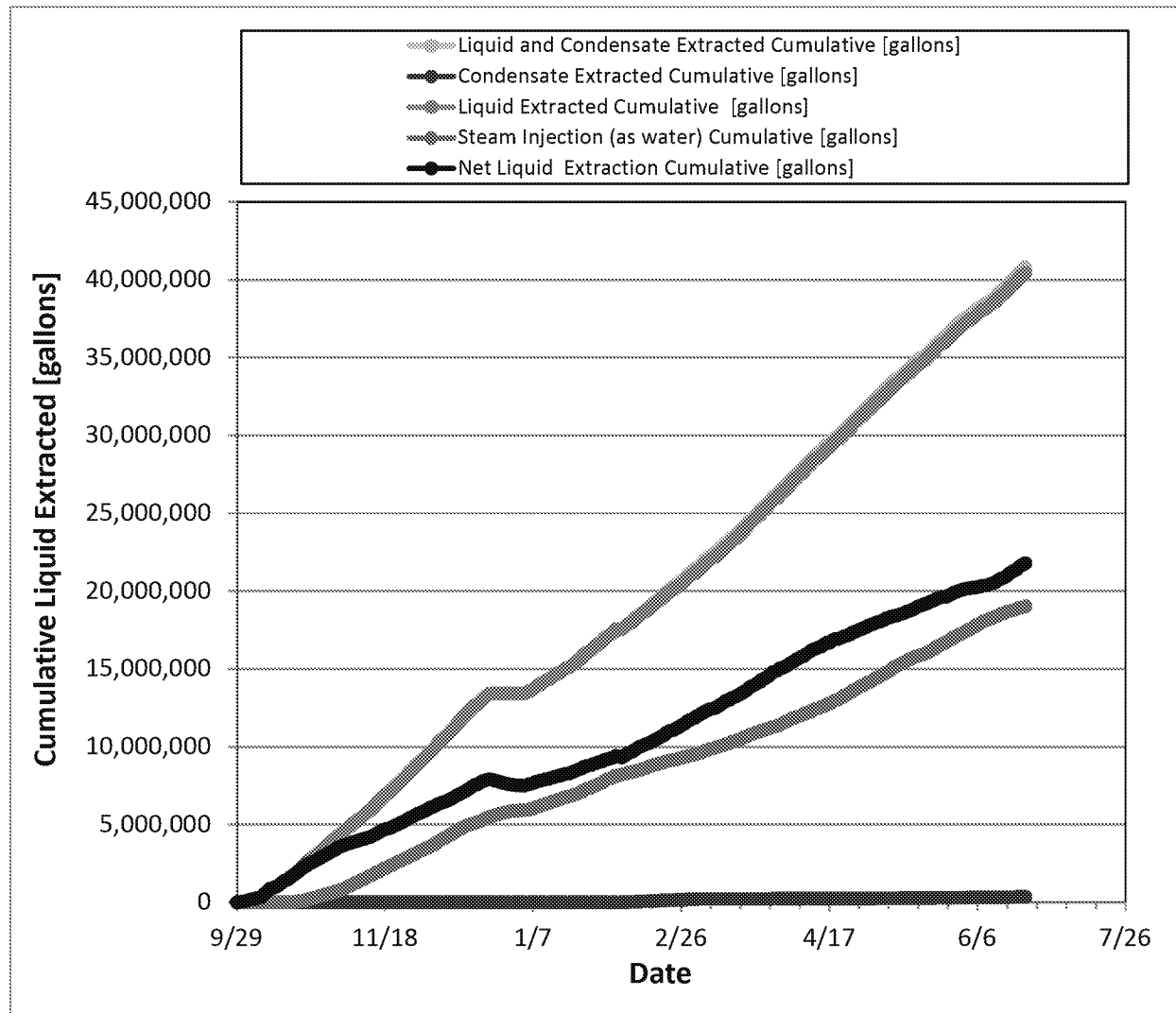


Figure 18. Cumulative Water Balance

14. Water Balance Rate

The total system water extraction rates are shown in the figure below.

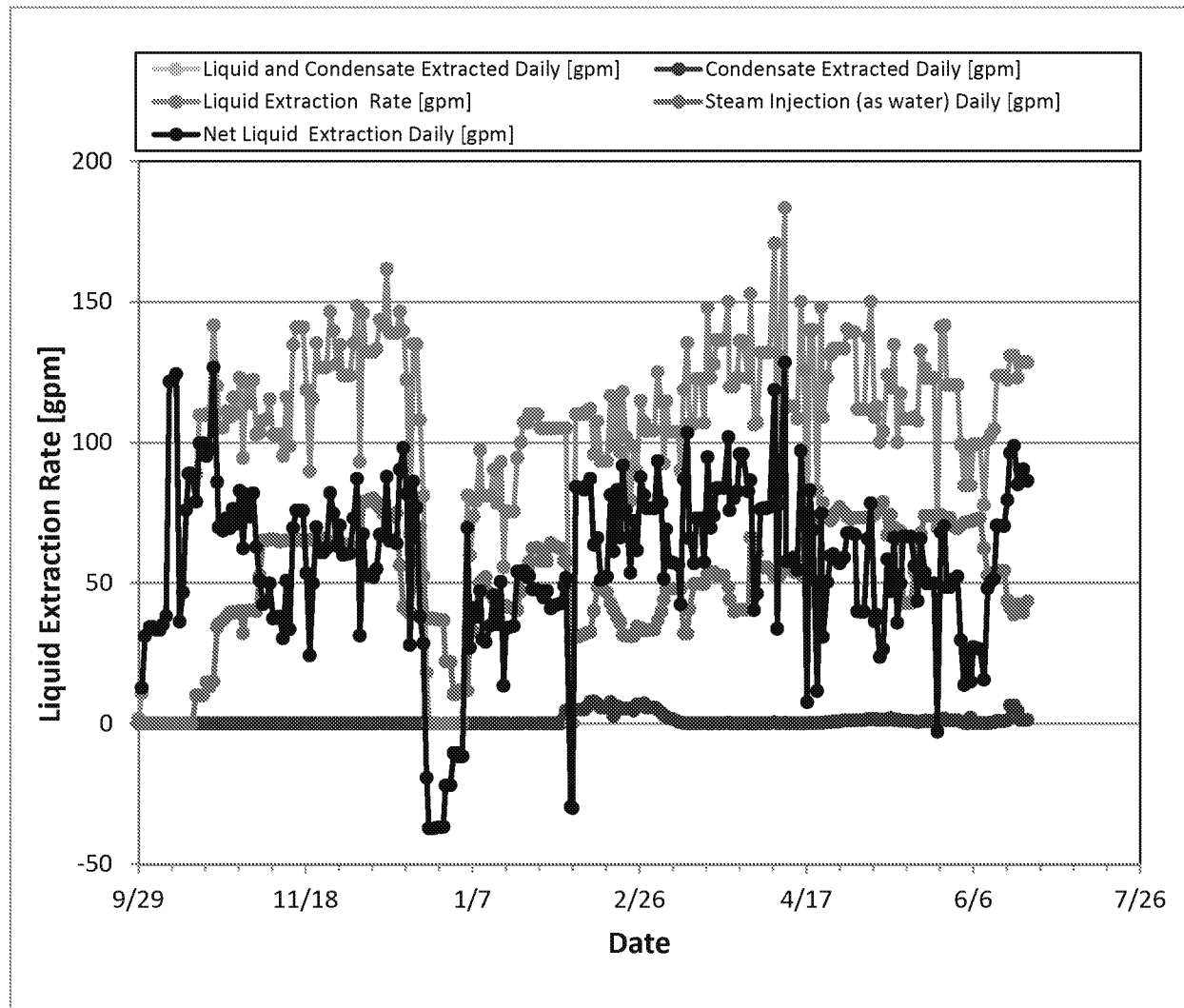


Figure 19. Water Balance Rates

15. Cumulative Energy Balance

The cumulative energy balance for the site is shown below. As shown below, the temperature of the extracted wellfield water (combined motive and formation water) is increasing and energy is starting to be extracted from the subsurface.

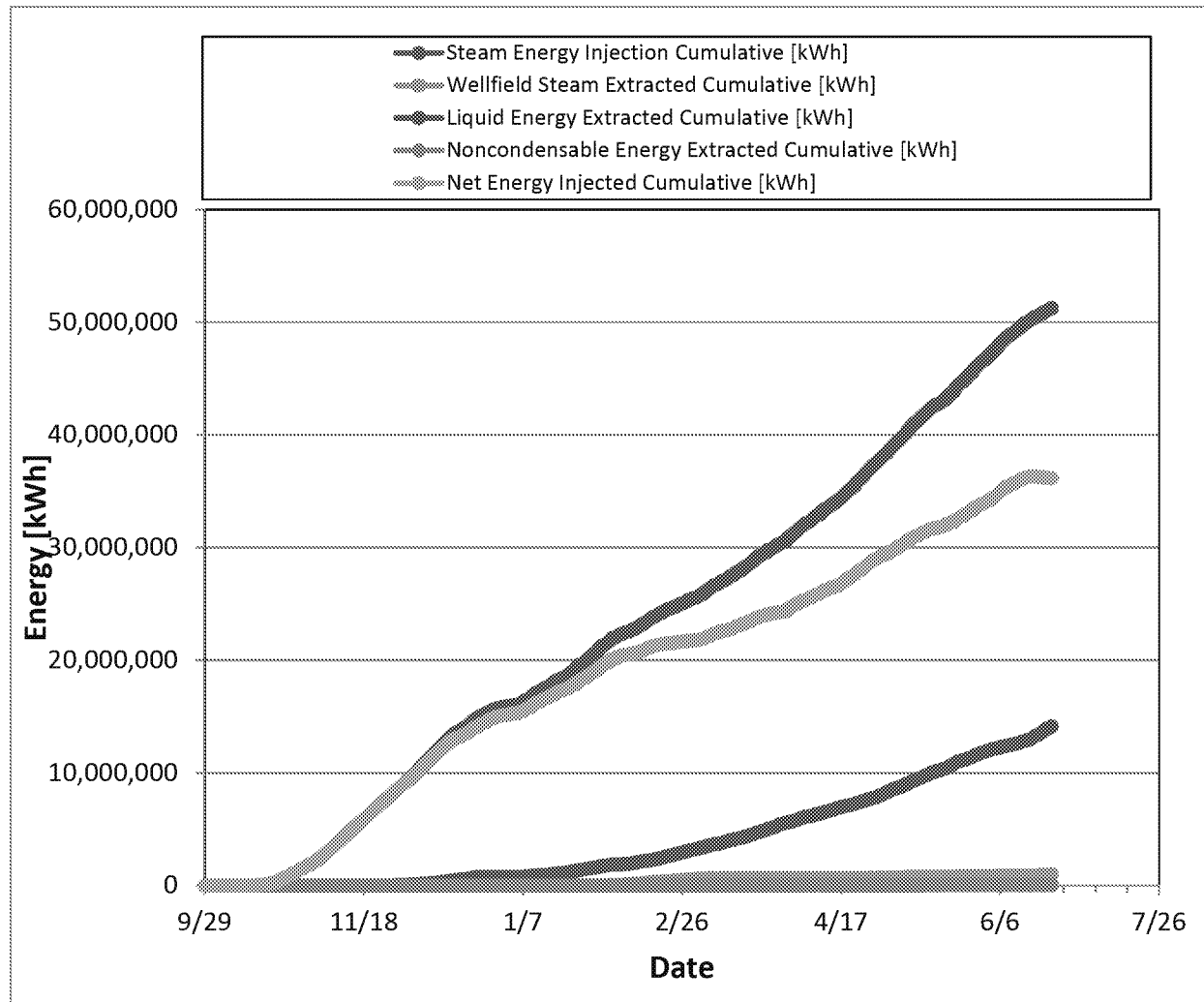


Figure 20. Cumulative Energy Balance

16. Energy Balance Rates

The energy balance rates are shown below. Please note that the net energy input currently is negative due to the pressure cycling, and thus limited steam input.

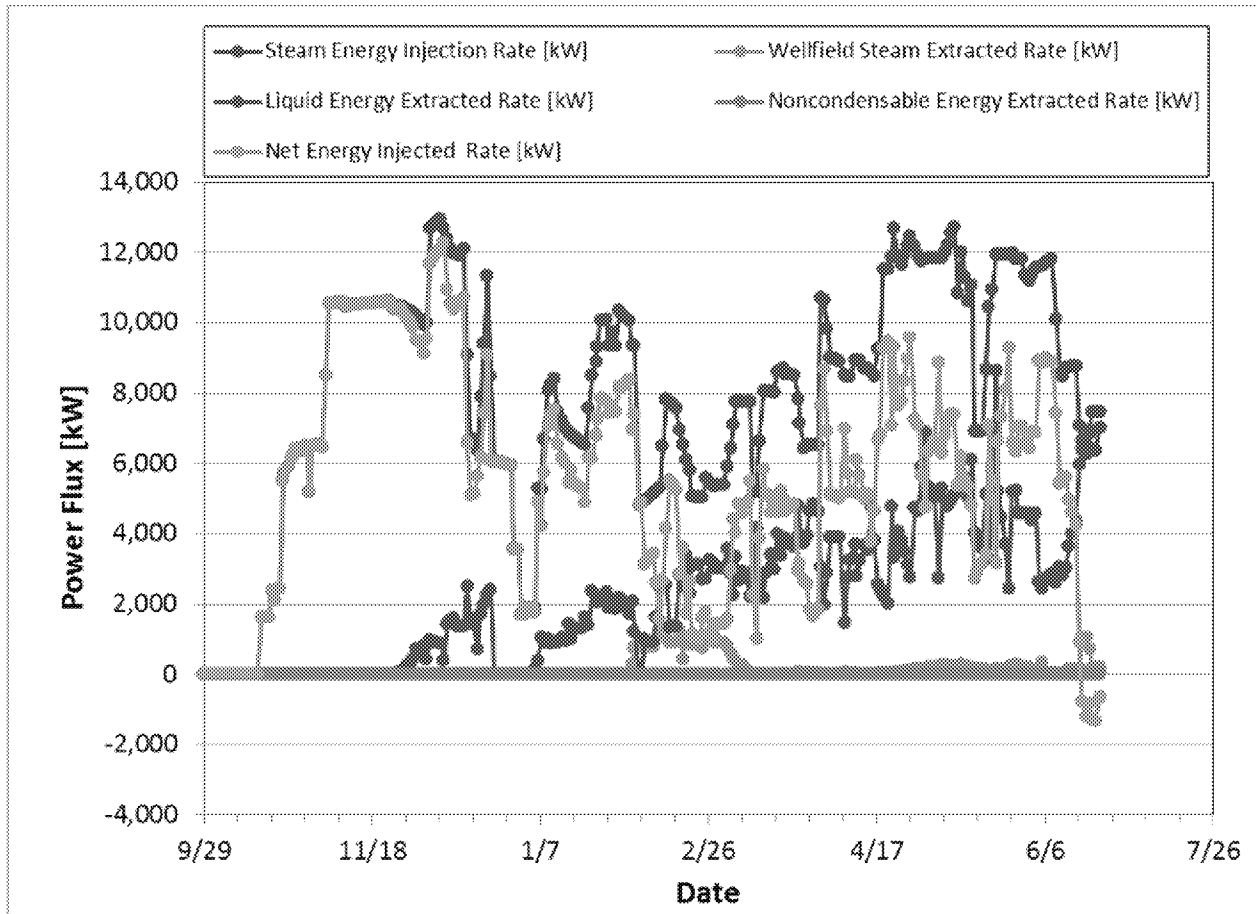


Figure 21. Energy Balance Rates

Note: At this time only limited energy has been extracted as steam from the site based on the condensate generated. Based on energy balance analysis, additional steam is likely being pulled into and condensing in the liquid extraction system.

17. Perimeter Water Level Data

Table 2 below presents the change in perimeter groundwater elevations since SEE system startup. The readings collected on September 24, 2014 (not shown) represent baseline conditions. A negative number shows that the groundwater elevation is lower than the baseline elevation, thus indicating an inward hydraulic gradient into the treatment zone. Liquid extraction began on September 29, 2014. Perimeter water level data are collected on a weekly basis. The regional groundwater table at the Site is increasing at a rate of approximately 1.5 ft/year; thus, each measured value shown in Table 2 has been corrected to take the regional changes into account.

Table 2. Perimeter Groundwater Elevation Changes

Monitoring Well	6/5/2015		6/9/2015		6/12/2015		6/19/2015	
	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous
CZ/UWBZ Wells								
ST012-C01	-0.36	-0.02	-0.35	0.03	-0.35	0.01	-0.44	-0.06
ST012-C02	-0.40	-0.03	-0.34	0.08	-0.42	-0.07	-1.10	-0.31
UWBZ Wells								
ST012-RB-3A	-0.05	0.08	-0.33	-0.26	-1.26	-0.92	-2.41	-1.12
ST012-U02	0.25	-0.12	0.07	-0.16	-0.40	-0.46	-1.53	-1.10
ST012-U11	0.15	0.30	0.07	-0.06	-0.46	-0.52	-1.87	-1.38
ST012-U12	0.27	0.14	0.08	-0.17	-0.58	-0.65	-2.58	-1.97
ST012-U37	0.09	0.12	-0.40	-0.47	-1.47	-1.06	-2.46	-0.96
ST012-U38	-0.08	0.10	-0.15	-0.05	-0.49	-0.33	-1.55	-1.03
LSZ Wells								
ST012-W11	0.30	0.05	-0.64	-0.04	-1.19	-0.53	-3.83	-2.62
ST012-W12	-0.36	0.02	-0.66	-0.28	-0.76	-0.09	-3.34	0.00
ST012-W24	-0.48	0.27	-1.12	-0.62	-1.20	-0.07	-3.22	-1.99
ST012-W30	2.15	1.37	-0.59	-2.72	-0.33	0.27	-1.51	-1.16
ST012-W34	-0.11	-0.04	-0.82	-0.69	-0.87	-0.04	-2.73	-1.83
ST012-W36	0.75	-0.09	-0.24	-0.97	-0.44	-0.19	-2.77	-2.30
ST012-W37	-0.74	0.01	-1.09	-0.33	-0.88	0.22	-5.24	-4.33
ST012-W38	-0.15	-0.02	-0.69	-0.52	-0.80	-0.10	-2.45	-1.62

June 24, 2015

Figure 22 shows the manually collected groundwater elevation trends since system startup. Additionally Figure 23 shows the groundwater elevations continuously logged in selected perimeter wells equipped with transducers. The regional groundwater table correction has also been applied to Figure 22 below.

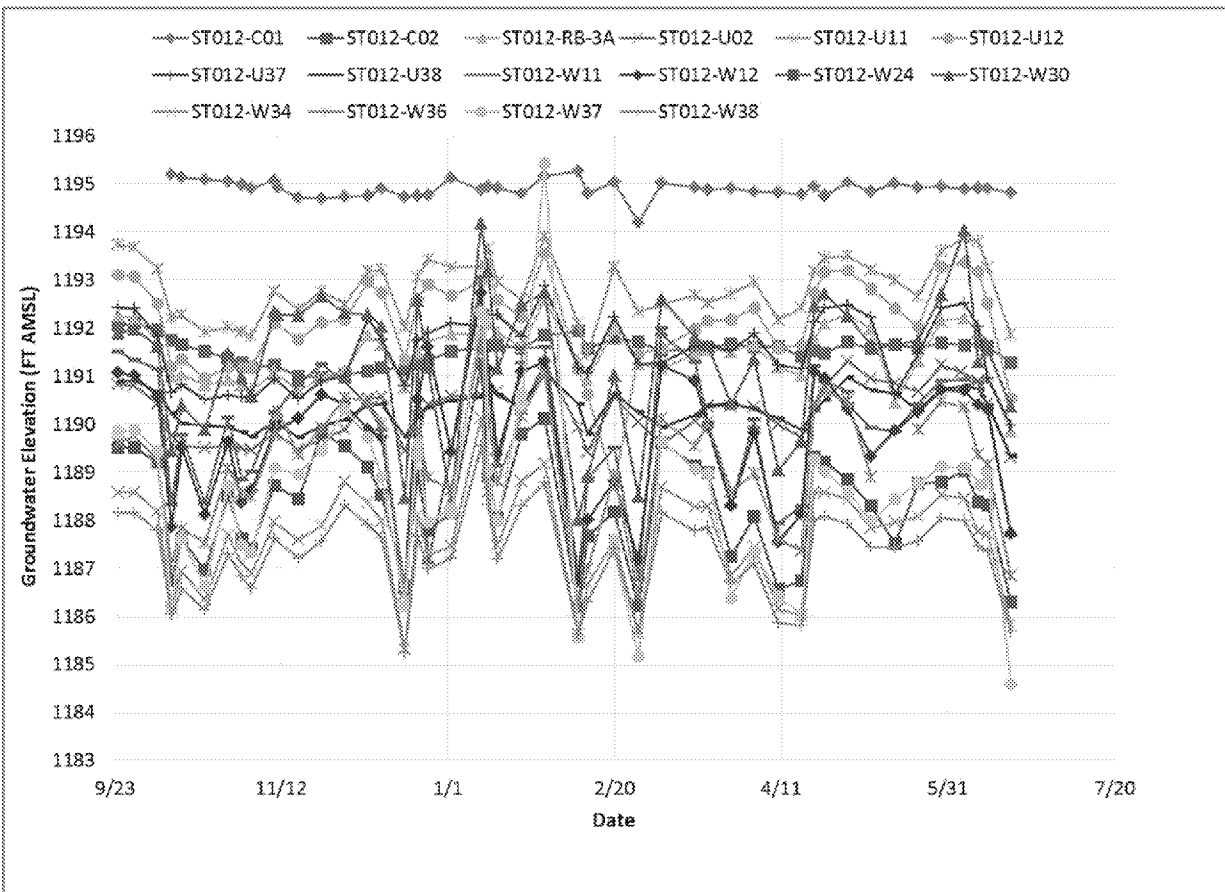


Figure 22. Manually Collected Perimeter Groundwater Elevations

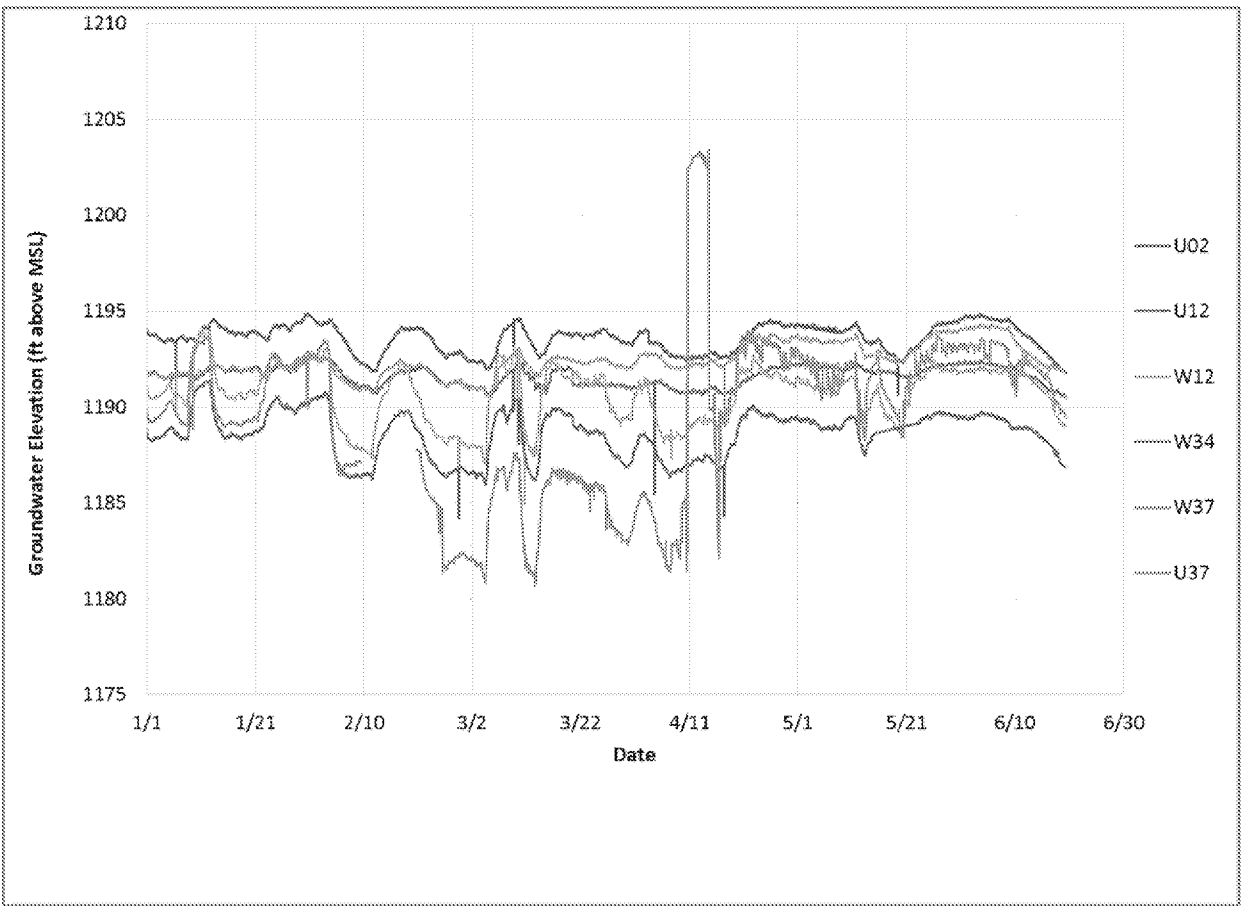


Figure 23. Automatically Collected Perimeter Groundwater Elevations

Table 3 below presents the measured LNAPL thicknesses of the perimeter wells at the site. The readings collected on September 24, 2014 represent baseline conditions while the readings collected after are during SEE operations. Perimeter LNAPL thickness data are collected on a weekly basis.

Due to low water levels during the June 19, 2015 bailing event, all NAPL was not able to be removed from wells W11 and W37, since the remaining NAPL was below the NAPL pump intake location.

Table 3. Perimeter LNAPL Thicknesses (ft)

Monitoring Well	6/9/2015-6/10/15		6/12/2015		6/19/2015	
	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing
CZ/UWBZ Wells						
ST012-C01	0.00	0.00	0.00	0.00	0.00	0.00
ST012-C02	0.00	0.00	0.00	0.00	0.00	0.00
UWBZ Wells						
ST012-U02	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U11	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U12	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U37	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U38	0.00	0.00	0.00	0.00	0.00	0.00
ST012-RB-3A	0.00	0.00	0.00	0.00	0.00	0.00
LSZ Wells						
ST012-W11	35.75	5.02	34.58	0.10	29.97	9.16
ST012-W12	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W24	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W30	10.67	0.42	8.49	0.28	18.81	0.06
ST012-W34	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W36	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W37	43.29	1.35	41.71	0.16	46.51	18.35
ST012-W38	0.00	0.00	0.00	0.00	0.00	0.00

June 24, 2015

On December 1, 2014, temperatures at selected perimeter wells were added to the monitoring program. Figure 24 below shows the manually collected temperatures recorded at the wells included in the monitoring program. Additionally Figure 25 shows the temperatures continuously logged in selected perimeter wells equipped with transducers.

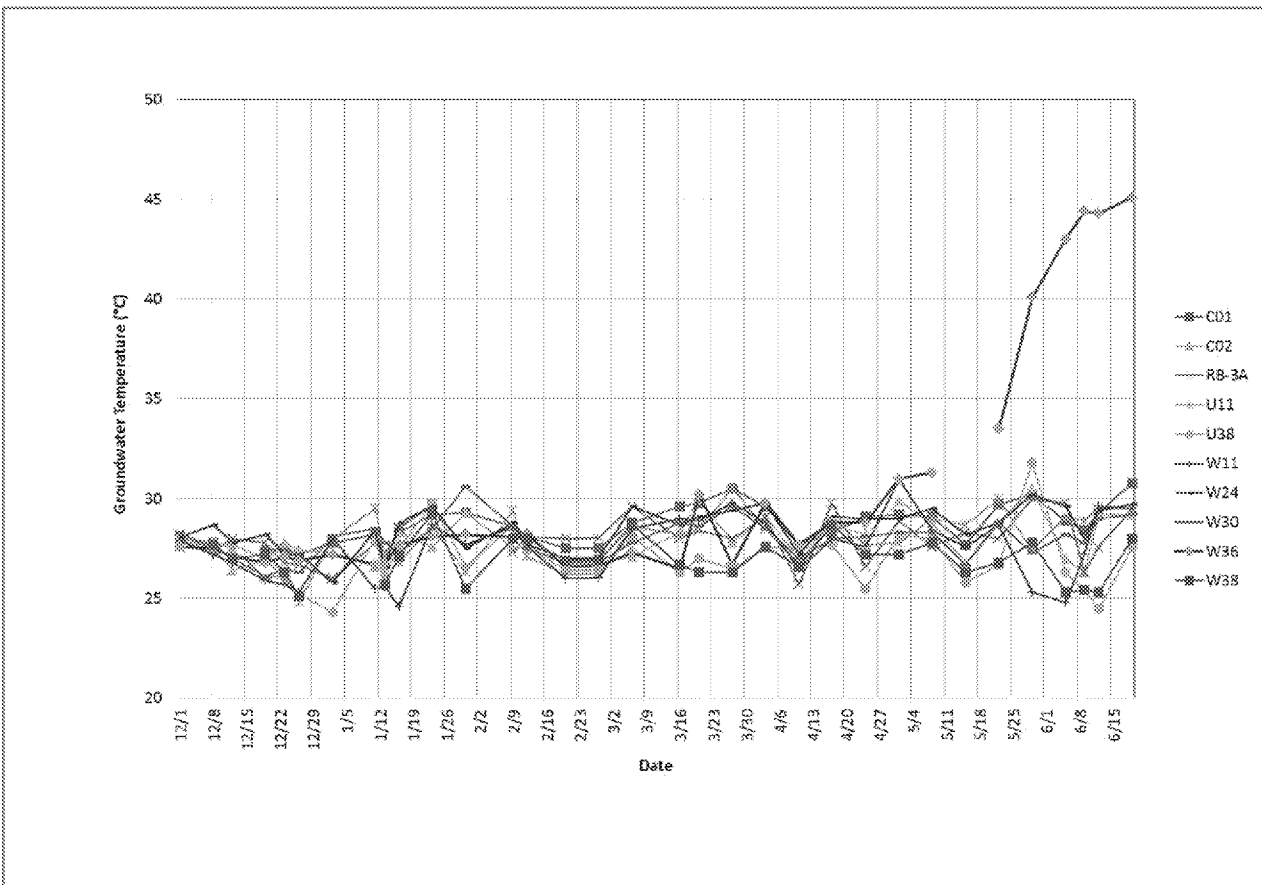


Figure 24. Manually Collected Perimeter Well Groundwater Temperatures

Note: Thermocouples are measured at approximate depths as follows (in feet below top of casing): C01=162; C02=168; RB-3A=161; U11=128; U38=164; W24=161; W30=134; W36=165; and W38=164. W11 will be measured during the week of June 15, 2015. U11 and W30 will be extended.

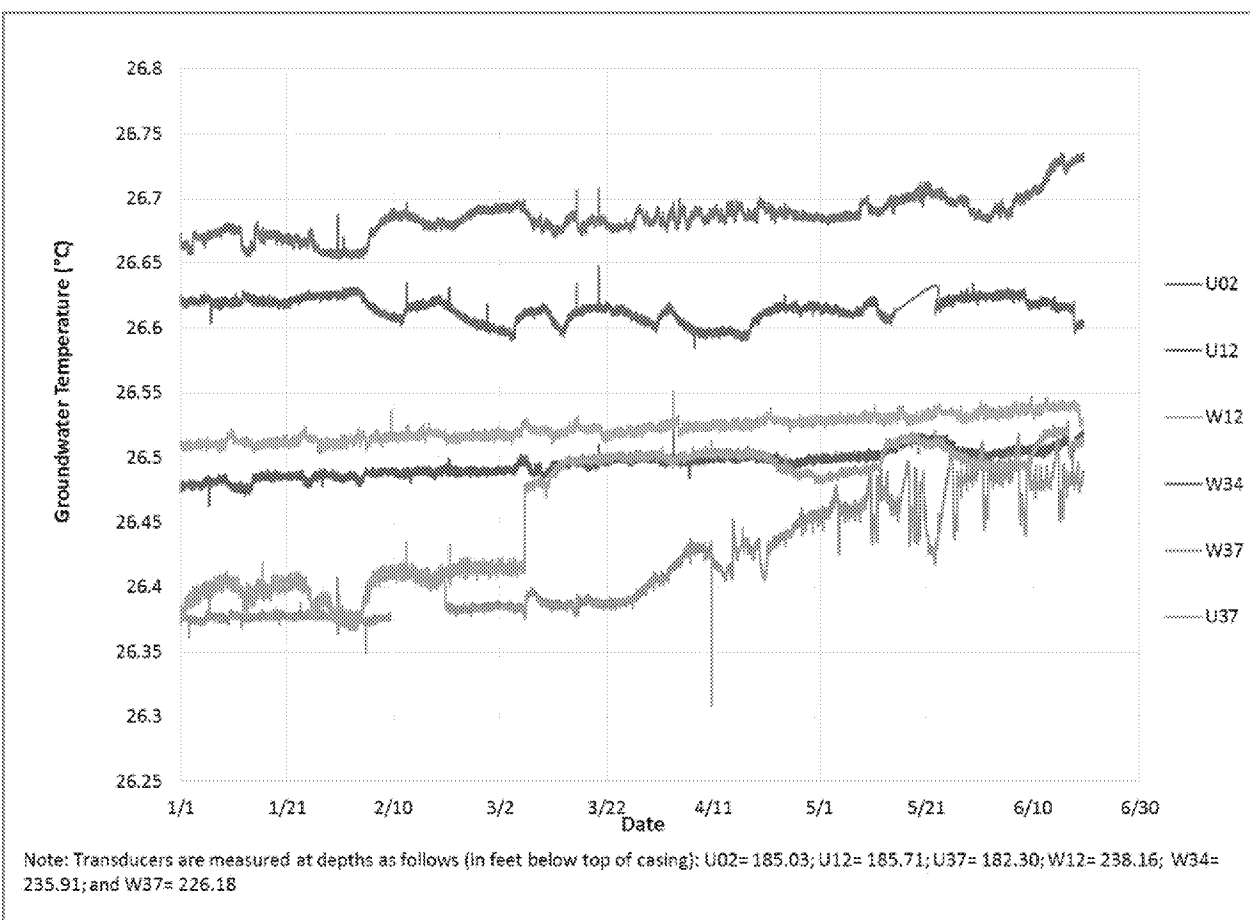


Figure 25. Automatically Collected Perimeter Well Groundwater Temperatures

Notes:

On March 7, 2015 operational personnel replaced the U37 logger unit. The increase in temperature on March 7, 2015 at U37 is a result of this replacement.

Transducers are measured at depths as follows (in feet below top of casing): U02= 185.03; U12= 185.71; U37= 182.30; W12= 238.16; W34= 235.91; and W37= 226.18

18. Natural Gas Usage

The following figure shows the natural gas usage rate in cubic feet per hour (cf/hr) and cumulative natural gas use in cubic feet (cf) to date at the site.

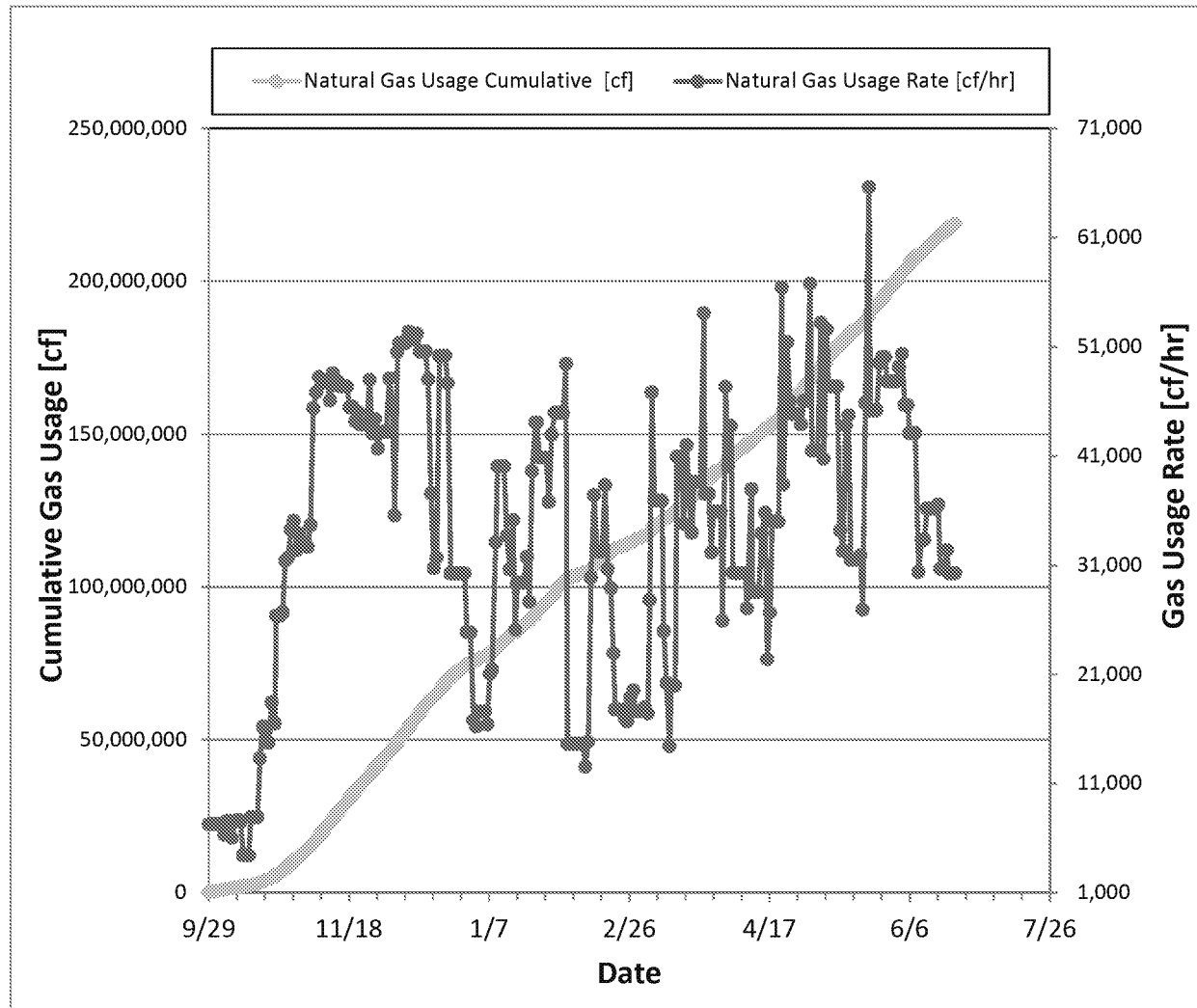


Figure 26. Natural Gas Usage

19. Waste Generation

On January 19, 2015 a total of 8,033 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 2,857 gallons or 18,800 lbs.

On February 18 and 19, 2015 a total of 24,430 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 3,645 gallons or 23,984 lbs.

On March 12, 2015 a total of 11,359 gallons of predominantly water from tank cleanout activities was removed from the site by Mesa Oil for recycling. The JP-4 mass in the water was limited.

On March 20, 2015 the first shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On March 30 and 31, 2015 a total of 32,000 lbs of spent liquid carbon was removed from the site by Evoqua Water Technologies for regeneration at their Red Bluff, CA facility.

On April 24, 2015 a shipment of bag filters (three cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On May 29, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On June 11, 2015 three 55-gallon drums of soil dug from around the Hypro NAPL filter were shipped offsite for non-hazardous disposal.

On June 10, 2015 a total of 5,727 gallons of oily bio-impacted water from tank cleanout activities was removed from the site by Mesa Oil for recycling.

20. NAPL Reuse

On April 7, 2015 a total of 12,647 gallons of stored NAPL was sent to Mesa Oil for reuse. The analysis showed that 703 gallons of the total fluid was water. The water has been subtracted from the NAPL recovery estimate.

On April 21-22, 2015 a total of 13,076 gallons of stored NAPL was sent to Mesa Oil for reuse. Analysis showed a water content between <1% to 3% or a total of 227 gallons of water. The water removed has been subtracted from the NAPL recovery estimate.

On May 7, 2015 a total of 5,722 gallons of stored NAPL was sent to Mesa Oil for reuse.

On May 21, 2015 a total of 1,400 gallons of stored NAPL was sent to Mesa Oil for reuse.

21. Estimated Formation Water Temperature

The calculated formation water temperatures are indicated in Table 4 below. The formation water temperatures have been calculated for each MPE well by measuring the eductor liquid feed and return flow rate together with the eductor liquid feed and return temperatures. The enthalpy increase in the liquid return temperature as compared to the liquid feed stream temperature is used to provide the MPE well specific formation temperature. Calculated formation water temperatures above the boiling point likely indicate that steam is being pulled into the liquid extraction system. These calculated data for each MPE well location are used in conjunction with the extracted vapor data collected at the MPE wells to make determinations on steam breakthrough around the site. All of these data are reviewed holistically (with other site data such as the TMP data) to determine when and where steam cycling events should commence.

Progress Report

Steam Enhanced Extraction Remediation at the Former Williams AFB ST012 Site, Mesa, AZ

June 24, 2015

Table 4. Calculated Well Formation Temperatures

Well	Formation Temperatures							
	5/29/2015	6/2/2015	6/4/2015	6/9/2015	6/10/2015	6/11/2015	6/15/2015	6/18/2015
	Temperature [°F]	Temperature [°F]	Temperature [°F]	Temperature [°F]	Temperature [°F]	Temperature [°F]	Temperature [°F]	Temperature [°F]
CZ11						123	133	119
CZ12	106	103	96	81	98	116	79	119
CZ14		137	111	117	100	130	102	116
CZ15								
CZ16		169	144	126	148	143	133	116
CZ17						91		
LSZ01	129	199	177	209	181	165	169	148
LSZ02	158		175	161	169	168	167	169
LZS04	215	260	283	299	483	358	626	3596
LSZ05			92			92		
LSZ06	136	204						
LSZ08	169	131	188	195	208	215	197	132
LSZ11	816	639	403	718	235	230	1072	209
LSZ12	120	166	160	160		192	173	119
LSZ13	189	155	213	186	184	203	130	134
LSZ14	176	154	161	172	168	198	191	110
LSZ15	195	287	232	135				
LSZ16	140	222	161	159	168		169	179
LSZ17	219	91	194	250	266	220	260	186
LSZ28	236	180	179	178	171	160	223	144
LSZ29	108	66	106	144	119	128	150	121
LSZ30	486	196	210	102				176
LSZ31	114	214		184	209	204	203	185
LSZ32	167	242	226	224	255	265	224	161
LSZ33	199	166	210	195	186	130	202	162
LSZ34	160	205	196	214	206	207	210	179
LSZ35	120	151	126	137	151	158	150	108
LSZ36	136	218	202	213	229	185	218	135
LSZ37	508	403	127		680			
LSZ38	183	239	66	100	54	157	113	243
LSZ39	140	153	134	161	164	166	162	169
LSZ40	179	252	221	240	274		246	159
LSZ42	190	176	159	179	193	217	189	163
UWBZ01	965	331	332	311	382	439	407	246
UWBZ02	212	216	236	293	292	284	304	241
UWBZ04	196	230	209	231	240		229	135
UWBZ06	166	266	164	196	181	259	197	149
UWBZ10	144	191	222	214	208	229	192	177
UWBZ17	242	244	252	275	258	247	255	195
UWBZ18	336	503	340	97	130	138	233	303
UWBZ19	197	240	218	209	221	213	237	
UWBZ20	112	151	133	123	125	119	131	124
UWBZ21	114	111	136	108	127	143	123	116
UWBZ22	109	135	170	149	176	174	194	121
UWBZ23	176	132	209		129	221	130	147
UWBZ24	140	142	132	158	152		177	120
UWBZ26	103	150	131	132	139	124	137	106
UWBZ27	698	124	116			86		

RED : at or above steam temperature (≥ 210 °F)
 GREEN : below steam temperature (< 210 °F)